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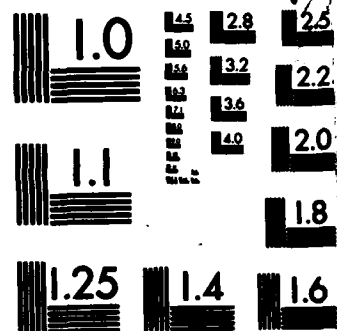UNCLASSIFIED   MATHEMATICS   J B KELLER APR 84 ARO-17902.40-MA
               DAAG29-81-K-0032   F/G 20/14   NL

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Nonlinear Phenomena in Electromagnetic and Acoustic Wave Propagation

Final Report

January 15. 1981 — January 14. 1984

Professor Joseph B. Keller

April 1984

U.S. Army Research Office

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REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
	A140 716	

4. TITLE *(and Subtitle)*	5. TYPE OF REPORT & PERIOD COVERED
Nonlinear Phenomena in Electromagnetic and Acoustic Wave Propagation	Final Report Jan 15,1981 – Jan. 14, 1984.
	6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)	8. CONTRACT OR GRANT NUMBER(s)
Professor Joseph B. Keller	DAAG29-81-K-0032

9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
Department of Mathematics Stanford Unversity, Stanford CA 94305	

11. CONTROLLING OFFICE NAME AND ADDRESS	12. REPORT DATE
U. S. Army Research Office Post Office Box 12211 Research Triangle Park, NC 27709	April 1984.
	13. NUMBER OF PAGES
	12 (twelve)

14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)*	15. SECURITY CLASS. *(of this report)*
	Unclassifie
	15a. DECLASSIFICATION SCHEDULE DOWNGRADING

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

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19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Nonlinear Phenomena in Electromagnetic
and Acoustic Wave Propagation

FINAL REPORT

January 15, 1981 - January 14, 1984

1. Statement of the problems studied

We have studied mathematical problems in electromagnetic and acoustic
wave propagation which involve nonlinear partial differential equations,
or linear partial differential equations with random coefficients.

2. Summary of the most important results

A general theory of weakly nonlinear high frequency wave propagation
was developed which applies to waves in any number of dimensions. It
justifies the nonlinearization technique of Whitham and Landau and extends
it to interacting waves and to other types of waves. The theory was
successfully applied to weak shock diffraction.

The theory of wave reflection from rough surfaces was extended to
yield the correlation functions of the scattered field. It was found that
the second order correlations could be expressed in terms of the reflection
coefficient and the differential scattering cross section of the surface.

Many other problems were analyzed successfully.

3. List of papers published and submitted for publication

See Attachment A.

4. List of scientific personnel

See Attachment B.

29. J. B. Keller   Temperley's model of gas condensation

     Pub: J. Chem. Phys., 74, 4203-4204, 1981.

30. J. B. Keller   Kelvin wave production
     J. G. Watson
                                     Pub: J. Phys. Ocean., 11, 284-285, 1981.

31. J. B. Keller   Recurrent precipitation and Liesegang rings
     S. I. Rubinow
                                     Pub: J. Chem. Phys., 74, 5000-5007, 1981.

32. J. B. Keller   Axisymmetric bubble or drop in a uniform flow
     M. J. Miksis
     J.-M. Vanden-Broeck   Pub: J. Fluid Mech., 108, 89-100, 1981.

33. J.-M. Vanden-Broeck   Numerical calculation of standing waves in
                                     water of arbitrary uniform depth

                                     Pub: Phys. Fluids, 24, 812-815, 1981.

34. R. E. Caflisch   Evaluation of a function at infinity from
     K. C. Nunan   its power series

                                     Pub: Phys. Rev. Letters, 46, 1255-1256, 1981.

35. J. B. Keller   Internal and surface wave production in a
     D. M. Levy   stratified fluid
     D. S. Ahluwalia
                                     Pub: Wave Motion, 3, 215-229, 1981.

36. R. E. Caflisch   Quench front propagation
     J. B. Keller
                                     Pub: Nuc. Eng. Design, 65, 97-102, 1981.

37. M. J. Miksis   A bubble in an axially symmetric shear flow

                                     Pub: Phys. Fluids, 24, 1229-1231, 1981.

38. J.-M. Vanden-Broeck   Deformation of a liquid surface by an impinging
                                     gas jet

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39. J. B. Keller   Oblique derivative boundary conditions and
                                     the image method

                                     Pub: SIAM J. Appl. Math., 41, 294-300, 1981.

40. R. Burridge   Poroelasticity equations derived from
      J. B. Keller   microstructure

                          Pub: J. Acoust. Soc. Am., 70, 1140-1146, 1981.

41. J. C. Neu   Stochastically perturbed resonance

                          Pub: SIAM J. Appl. Math., 41, 365-369, 1981.

42. M. J. Miksis   Shape of a drop in an electric field

                          Pub: Phys. Fluids, 24, 1967-1972, 1981.

43. J.-M. Vanden-Broeck   The influence of capillarity on cavitating
                                    flow past a flat plate

                          Pub: Quart. J. Mech. Appl. Math., 34,
                                    465-473, 1981.

44. A. Jeffrey   A note on the effect of submerged obstacles
      J. Mvungi   on water waves in a channel

                          Pub: J. Appl. Math. Phys., 32 756-763, 1981.

45. P. S. Hagan   Target patterns in reaction-diffusion systems

                          Pub: Adv. Appl. Math., 2, 400-416, 1981.

46.* P. S. Hagan   Diffusion-induced morphongenesis in the
       M. S. Cohen   development of Dictyostelium

                          Pub: J. Theor. Biol., 93, 881-908, 1981.

47. P. S. Hagan   Nuclear magnetic-resonance studies of cation-
      D. Z. Ting   transport across vesicle bilayer membranes
      J. D. Doll   Pub: Biophys. J., 34, 189-214, 1981.

48. A. Jeffrey   A note on the multiple scale Fourier transform
      T. Kawahara   Pub: Nonlinear Anal., Theory, Methods and
                                   Applics., 5, 1331-1340, 1981.

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    Pub: Management Sci., 28, 447–450, 1982.

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    Pub: SIAM J. Appl. Math., 43, I, 141–156, 1983.

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    Pub: SIAM J. Appl. Math., 43, II, 268–277, 1983.

61. A. Jepson, A. Spence — Folds in solutions of two parameter systems and their calculation: Part I
    Pub: Stanford Univ. Numer. Anal. Report, 82-02.

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    B. Nicolaenko — Shock profile solutions of the Boltzmann equation
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    M Seul
    H. L. Frisch
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     Acc: J. Australian Math. Soc. B, in press.

73. R. E. Caflisch   Dynamic theory of suspensions with Brownian
     G. C. Papanicolaou   effects

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     G. C. Papanicolaou   to Brownian effects

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     B. Nicolaenko

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     L. A. Segel   unstirred bulk

     Pub: SIAM J. Appl. Math., 43, 386-416, 1983.

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     J. L. Frisch   diffusion measurements

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     H. L. Frisch
     J. B. Keller   Pub: Chem. Eng. Sci., 39, No 3, 601-604, 1984.

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     J. B. Keller

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     J. Mvungi   water profile after the collapse of a dam wall

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     E. L. Reiss

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Pub: SIAM J. Appl. Math., 42, 135-148, 1982.

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     J. B. Keller

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Pub: Commun. Math. Phys., 87, 567-576, 1983.

86. M. Cheney

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     A. Liñán

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waves in the diffusive Volterra delay-differential
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     J. Hunter

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     J. Hunter

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     J. C. Neu

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     J.-M. Vanden-Broeck

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resistance

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      Hydrodynamics, Paris, France, June 16-19, 1981.

93. A. Spence   The numerical computation of turning points of
       A. Jepson   nonlinear equations

Pub: Treatment of Integral Equations by Numerical
        Methods, 169-183, London, 1982.

94. J. B. Keller   Biot's poroelasticity equations by homogenization
       R. Burridge

Pub: Springer Lecture Notes, in Macroscopic
        Properties of Disordered Media, NY, 51-57,1982.

95. J. B. Keller   Capillary waves on a vertical jet

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96. J. B. Keller   Survival estimation using censored data
       A. S. Whittemore

Sub: J. Royal Statist. Soc., Series B

97. J. B. Keller   Eigenvalues of slender cavities and waves in
       J. F. Geer   slender tubes

Pub: J. Acoust. Soc. Am., 74, 1895-1904, 1983.

98. J. B. Keller   Valuation of stocks and options
       R. Voronka

To be submitted.

99. M. Cheney   Inverse scattering in dimension two

Acc: J. Math. Phys., in press.

100. K. C. Nunan   Effective viscosity of a periodic suspension
        J. B. Keller

Acc: J. Fluid Mech., in press.

101. K. C. Nunan   Effective elasticity Tensor of a Periodic Composite
        J. B. Keller

Acc: J. Mech. Phys. Solids, in press.

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Pub: Phys. Fluids, 26, 3451-3453, 1983.

103. J. B. Keller   Hanging rope of minimum elongation
        G. R. Verma

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104. M. Cheney   Velocity & density of a two-dimensional acoustic
      S. Coen   medium from point source surface data
      A. Weglein
                              Sub: Phys. Rev. Lett.

105. J. B. Keller   Probability of a shutout in racquetball

                              Acc: SIAM Rev., in press

106. S. Venakides   The Zero Dispersion Limit of the Korteweg-de Vries
                              Equation for Initial Potentials with Non-trivial
                              Reflection Coefficient

                              Acc: Comm. Pure Appl. Math.

107. J. H. Maddocks   Stability of Nonlinearly Elastic Rods

                              Acc: Arch. Rat. Mech. Anal., in press.

108. J. B. Keller   Genetic Variability Due to Geographical Inhomogeneity

                              Sub: J. Math. Biol.

109. J. B. Keller   Precipitation pattern formation
      M. S. Falkovitz
                              In preparation.

110. V. Twersky   Scattering and Nonscattering Obstacles
                              Pub: SIAM J. Appl. Math., 43, No 4, 1983.

111. R.E. Caflisch   Nonlinear Dynamical Theory of the Elastica
      J.H. Maddocks
                              Sub: Proc. Roy. Soc. Edin.

112. J.B. Keller   Rough Surface Scattering via the Smoothing Method
      J.G. Watson
                              Acc: J. Acoust. Soc. Am.

113. J.B. Keller   Free boundary problems in mechanics

                              Acc: Lectures in Partial Differential Equations
                                         S.S. Chern, editor, Springer New York, in press.

114. J.B. Keller   Newton's second law

                              Sub: Am. J. Physics

Attachment B.

Army contract DAAG29-81-K-0032

Scientific Personnel, January 15, 1981 through January 14, 1984:

Russell E. Caflish

Jeanmarc Vanden Broeck

John G. Watson

Meira Falkovitz

John H. Maddocks

Margaret Cheney

Michael Weinstein

Graham P. Eatwell

Stephanos Venakides

John A. Fawcett

END

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